ZENNIO "Building" Thermostat

Version: 1.1

Document edition: a

INDEX

DOCUMENT UPDATES

Version	Modifications	Page(s)
1.1a	Change in the name of the following parameters: *"Upward adjustment of basic setpoint"* → *"Maximum offset"* *"Downward adjustment of basic setpoint"* → *"Minimum offset"* *"Cycle time"* → *"PI Cycle"* *"Sending period"* → *"Resending period"*	8,28,30,31,32,34
	Table 1.1 extended: The Roll-ZAS 1.0 application has been added	4
	New naming for the specific documentation (Version 1.1, Edition a)	Title

1. INTRODUCTION

1.1. DEVICES ZENNIO WITH THERMOSTAT

In the table 1.1 it is shown the Zennio devices (device name and application program version) that currently have incorporated the Bulding thermostat functionality explained in the present documentation. This table will be updated every time the number of versions and devices on which the thermostat functionality is implemented increases.

Device	Application Program Version
InZennio Z38i	2.1
QUAD	4.0
ZAS (Roll-ZAS)	1.0

Table 1.1. Zennio devices with Building thermostat functionality implemented

Note: *For more detailed information about the thermostat parameterization of all these Zennio products, please consult the "**ETS Configuration**", in the section 3 of this document.*

2. THERMOSTAT CONFIGURATION

A serial of general concepts concerning the Zennio thermostat configuration are explained below:

2.1. TEMPERATURE

To carry out a thermostatic control it is necessary to properly define the following parameters:

🔵 **Setpoint temperature**: it is the desired temperature for the room to climate. It is set by parameter and can be modified, depending on the clima needs of every moment.

🔵 **Reference temperature**: it is the ambient (real) temperature of the room. This temperature will be used as reference to do the automatic switching between modes. It can be get from an external KNX device with the ability to measure temperatures. As reference temperature, it can be also used a mixture of temperatures, measured from two different sources (either from the internal probe that some devices incorporate or from two external sources), with the following proportions:

Proportion	Source 1	Source 2
1	75%	25%
2	50%	50%
3	25%	75%

Table 2.1. Reference temperature proportions

2.2. FUNCTIONING MODES

It is necessary to define the thermostat functioning mode, choosing one of these: Cooling, Heating or both. In function of the selected mode, the thermostat will react to situations of only cooling, only heating or both, respectively.

In case of selecting both functioning modes, the automatic switching between modes can be enabled (if it remains disabled, the mode switching will be carried out manually, through a 1 bit communication object). Moreover, the mode after programming (Cooling or Heating) can be selected by parameter since, depending on the place where the thermostat is installed, it will be more convenient to start working in a mode or in the other.

2.2.1. AUTOMATIC MODE SWITCHING

The automatic mode switching of the thermostat consists of establishing the corresponding mode (Cooling or Heating) in function of the difference between the reference temperature (real measured temperature) and the setpoint temperature of the current special mode (see section 2.5: Special Modes). The criterion followed to carry out this automatic switching is detailed in <u>section 4.1</u>.

2.3.   CONTROL METHOD

The thermostatic control of an installation consists of the generation of control signals that will allow reaching the desired setpoint temperature, besides getting a stabilization around that setpoint value. This temperature control can be carried out in two different ways, depending on the algorithm used for the calculations. Zennio thermostat can be controlled through any of the following methods:

- **2 point control**

- **Proportional integral (PI)**

2.3.1. 2 POINT CONTROL

The 2-point hysteresis control system is implemented in conventional thermostats. For its proper functioning, it is compulsory to establish a **setpoint temperature** and **two hysteresis values** (lower and upper), for the aim that the system is not continuously switching around a setpoint temperature in brief periods of time.

Please read the following example about the 2 point control functioning.

✓ Example:

Suppose a setpoint temperature equal to 25ºC is established (mode Heating) and both the lower and upper hysteresis are equal to 1ºC. The initial room temperature is 19ºC. When the temperature reaches 25ºC, the system will go on heating, until the temperature reaches 26ºC. Once the upper hysteresis is reached, the system is switched off. While the system is off, the temperature begins to decrease, but the system will not be switched on at 25ºC (setpoint temperature), it will do it when the lower hysteresis is reached, this is, when the romm temperature is equal to 24ºC.

In the course of this process, it is obtained a very typical graph similar to the saw teeth. See Figure 2.1:
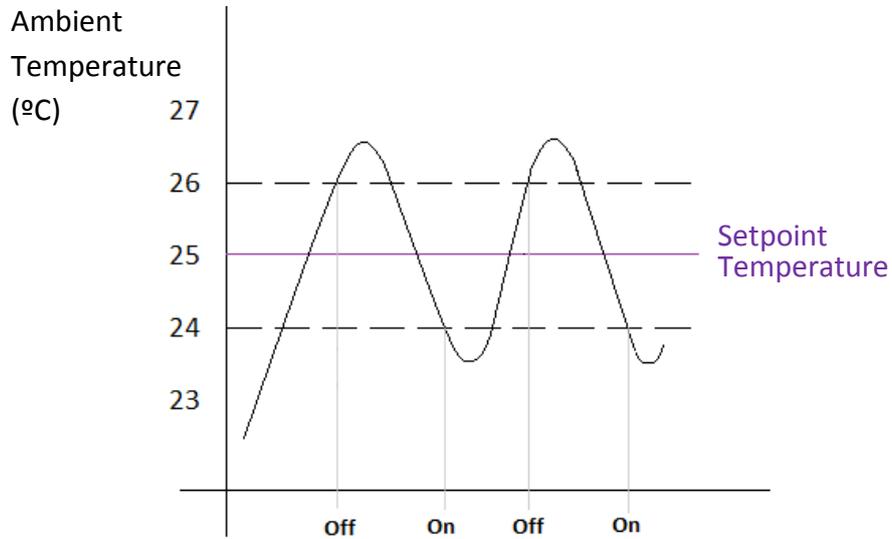

Figure 2.1. Typical graph of 2 point with hysteresis system

The problem of this control type, compared with other more developed systems, is the continuous oscillation around the setpoint temperature, which has direct influences in the energetic consumption and comfort.

In the figure 2.2, this oscillation is shown, where the red zones indicate an excess in the energetic consumption, because the room temperature is upper than the setpoint temperature, whereas the blue zones indicate a lack of comfort, because the room temperature is lower than the seetpoint temperature.
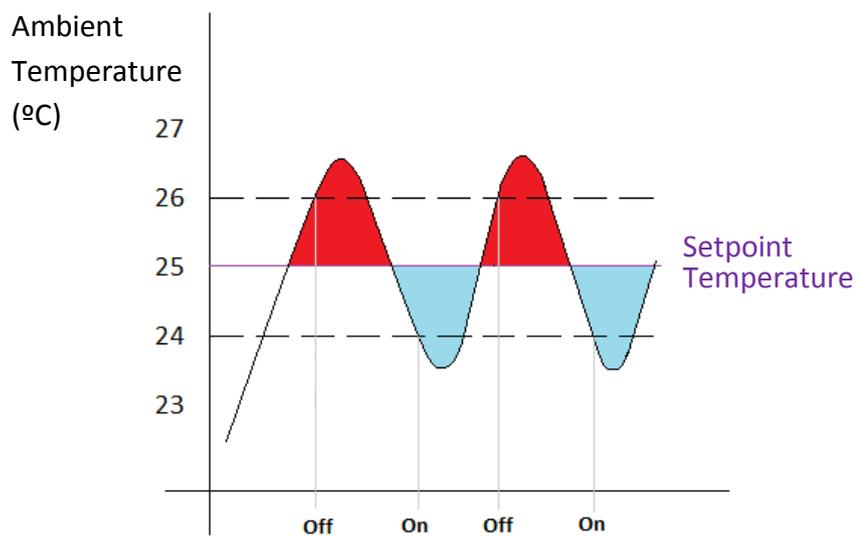

Figure 2.2. Inefficiency of 2 point control

Note: *The blue zone (lack of comfort) does not compensate the excess of energetic consumption of the red zone.*

2.3.2. PROPORTIONAL INTEGRAL

Second possibility offered in Zennio´s products for carrying out the thermostat function. In short, this control type could be defined as a system of integral calculation that depends on two parameters:

🔵 **K: Proportional constant:** measured in kelvin (K). It allows estimating one error value proportional to the difference between the setpopint temperature and the room temperature.

🔵 **T: Integration time:** in minutes. Value that depends on the thermal lag of the air-conditioning system that allows adjusting the approximation error in connection with the elapsed time.

When configuring this control type, a drop-down box will appear with a series of predefined **control parameter,** with prefixed K and T values, depending on the chosen mode (Cooling or Heating). To know these values, please consult section 5.2 on this document.

It is also given the chance of manually setting the parameters K and T, but this is only advised for air-conditioning experts.

Moreover, it is necessary to specify the **PI cycle time** for carrying out the calculations. This PI cycle depends a lot on the thermal lag of the air-conditioning system that is being installed.

The PI control has two variants:

🔵 **PI Continuous:** 1 byte control variable, in percentage, which indicates the opening percentage that the valve has to acquire in a certain time cycle. For instance, a value equal to 50% for the PI-Continuous is indicating the valve to open in half.

The inconvenient for this type of control is that the systems need more sophisticated valves, which control is more complex, thus increasing the installation cost.

🔵 **PWM (Pulse Width Modulation):** 1 bit control variable that sends to the thermostat valve the opening and closing orders (value "1" and "0", respectively). The time the valve remains opened and closed during each cycle depends on the internal calculations the thermostat

makes, in function of the parameterized K and T values and the setpoint and reference temperatures.

The valves are now "all-nothing" valves, less complex than the ones for PI Continuous control.

One of the advantages of the PI control over other control methods is that, from a certain instant, the temperature tends to correctly stabilize around the setpoint value, without the oscillations of the 2 point control (see figure 2.2). The speed and smoothness with which the temperature suits the setpoint depends on the chosen control parameters (see section 4.2).

Next an example of thermostatic control using PI Continuous (and its equivalent PI-PWM) is shown.

✓ *Example:*

Suppose the value of PI-Continuous variable is equal to 50%. In this case, the valve will open in half staying there all the cycle time. The equivalent PWM variable maintains a pulse equal to "1" during the first time cycle (Ton) and a pulse equal to "0" during the last hasl tiem cycle (Toff). Figure 2.3.

When the value of PI-Continuous is equal to 25%, the valve will open to 25%, staying at that percentage all the cycle time. The equivalent PWM variable maintains a pulse equal to "1" during 1/4 of the cycle time and a pulse equal to "0" during 3/4 of the cycle time. Figure 2.4.
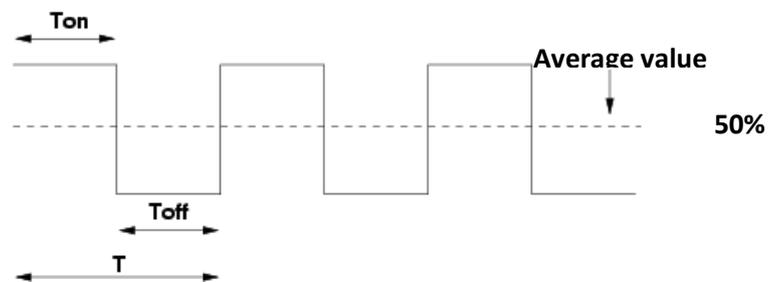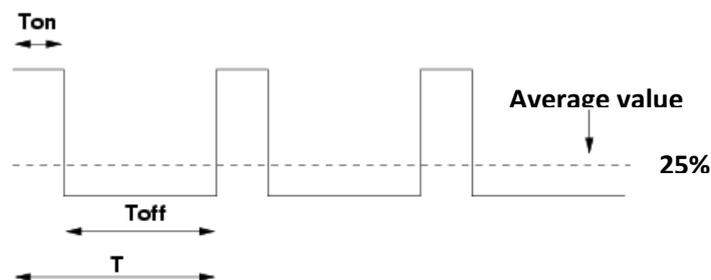

Figure 2.3. Value of variable PI equal to 50%

Figure 2.4. Value of variable PI equal to 25%

To finish, a typical graph (figure 2.5) of the temperature evolution inder a PI control system is shown (theoretical graph that is not result of any real simuation), as well as a comparison between the two methods: 2 points with hysteresis and PI (Figure 2.6).
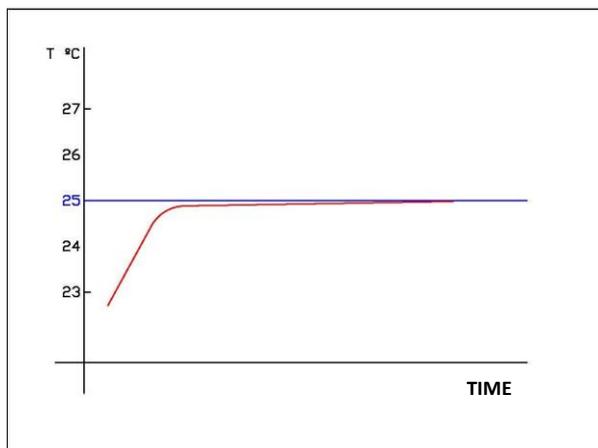

Figure 2.5. Typical graph of PI system
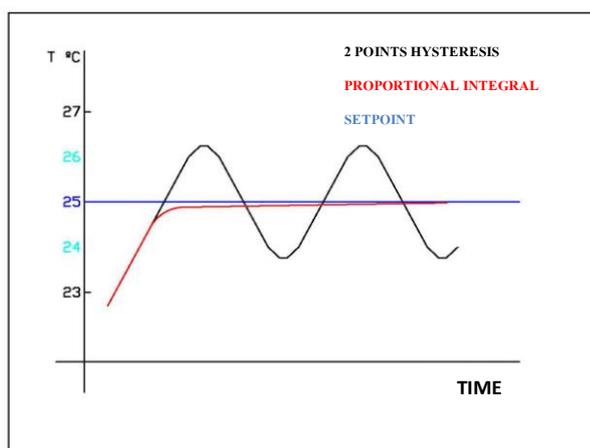
Figure 2.6. Ideal comparison: PI control vs. 2 point control

2.4. ADDITIONAL COOLING/HEATING

Zennio's thermostat incorporates the possibility of using **additional heating or cooling sources**, in order to control the temperature in the rooms to acclimatize (in case of having more than one air-conditioning system). This function is very useful to make the most of installations, because the **comfort** provided by them is increased, since different air-conditioning systems interact with the same aim.

For a proper configuration of the additional Cooling/Heating it is necessary to define an **additional band** (in tenths of degrees) where the additional system begins to work.

The intervention of the additional system is carried out as follows, depending on the parametrized mode:

🔵 **Cooling mode:** when the room temperature (reference) is **higher or equal** than the **setpoint plus the additional cooling band**, the additional system will start working for increasing the cooling of the room. The additional cooling will be switched off (thus switching off the additional system) when the real temperature is lower or equal than the setpoint plus the band minus 0.5ºC. See figure 2.7.

Figure 2.7. Additional Cooling example

🔵 **Heating mode:** when the room temperature (reference) is lower or equal than the setpoint minus the additional heating band, the additional system will start working for increasing the heating of the room. The additional heating will be switched off (thus switching off the additional system) when the real temperature is higher or equal than the setpoint minus the band plus 0.5ºC. See figure 2.8.
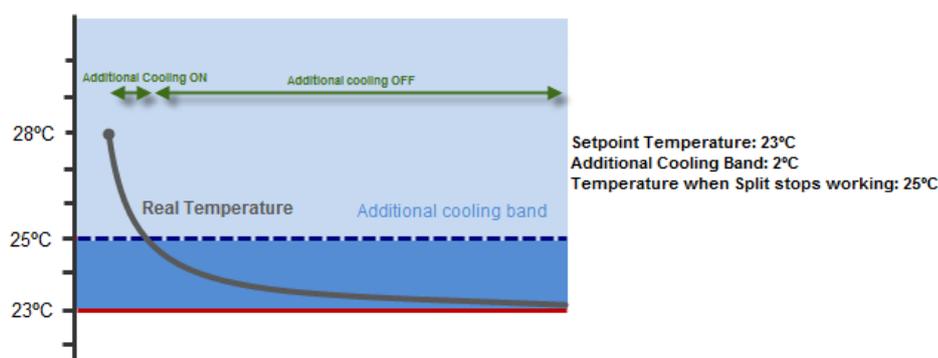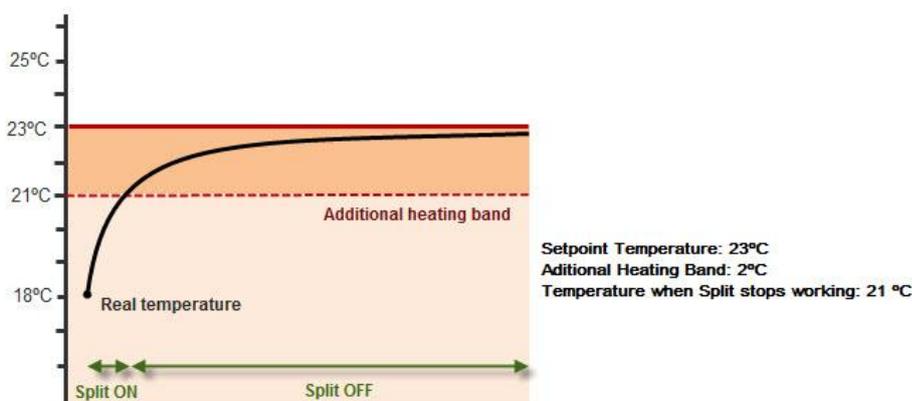

Figure 2.8. Additional Heating example

As **practical example**, consider the use of a Split as additional heating source in a room where the main air-conditioning system is a radiant floor which has a slower thermal lag than other systems like the Split and it reacts more gradually to setpoint temperature. That is the reason why the Split is a suitable system when a great temperature changes are required (for example, an increase of 2ºC in setpoint temperature). Data are:

- *Main air-conditioning system: Radiant floor*

- *Additional Heating system: Split*

- *Additional Heating band: 3ºC*

- *Room Temperature: 22ºC*

At a given moment, a setpoint temperature equal to 26ºC is required. Since the real temperature of the room is lower than the setpoint minus the band (23ºC), the additional heating system (Split) is activated. Once the temperature reaches 23.5ºC, the additional system will be switched off.

2.5. SPECIAL MODES

Zennio thermostat can work in any of the following special modes: **Protection, Comfort, Standby** and **Economy**. With these special modes it is possible to stablish different setpoints temperatures to get an optimal comfort situation in each case.

🔵 **Comfort mode**: this mode is normally activated when the room to acclimatize is being used. In this case, the temperature must be adjusted to achieve a comfort status for the people inside.

🔵 **Standby mode**: this mode is normally used when the room to acclimatize is being empty for a short period of time, for example, when the people who is working in one room must move to another for a meeting, but once finished they will return to the first room. In this case, a Standby temperature is established, thus shaving energy.

🔵 **Economy mode:** this mode is normally used when the room to acclimatize is being empty during longer periods of time, for instance, when people in the room go to sleep and the room will not be used until the next day. Usually, this mode adjusts the room temperature to lower or higher values, depending on the functioning mode (Heating or Cooling, respectively).

🔵 **Protection mode:** this mode is thought to be enabled when "extraordinary" events occur, excessive cooling or heating events, mainly due to an anomalous external situations (like a

broken window) or because the room to acclimatize is being empty for a very long period of time. In these cases, since the protection setpoint is so high (Cooling mode) or so low (Heating mode), the thermostatic control will be enabled only if the thermostat is ON and with the protection mode activated and when the room temperature (reference) is really higher or lower than the parameterized protection setpoints, thus avoiding an excessive energy consumption.

Note: *The thermostat will be always working in one of the special modes mentioned before.*

It is necessary to define the **setpoint temperatures** for every mode and the way on which these setpoints can be modified, in function of the acclimatization needs. For this aim, Zennio thermostat has two methods: **absolute setpoints** and **relative setpoints.** Whatever the chosen method, the functioning mode (Cooling or Heating) of the thermostat will determine a cooling and a heating setpoint, thus making that a mode switch just implies a change in the thermostat setpoint. In sections 2.5.1 and 2.5.2 both methods are explained in detail.

Note: *Although the setpoints are customizable, it is important to know that an **efficient configuration** implies the Standby setpoint to be set between the Comfort and Economy setpoints.*

2.5.1. ABSOLUTE SETPOINTS

With the Absolute setpoints method a **total control** over the desired temperature in the room is achieved, since the thermostat controls the temperature of the room in function of the setpoint temperature it receives through a 2-byte communication object.

It is necessary to define a setpoint for the special mode Comfort, from which the setpoints of the other modes are defined. I.e., Standby and Economy setpoints are established through an offset relative to the absolute setpoint defined for the Comfort mode, according to the chosen functioning mode (Cooling, Heating or both, in which case a setpoint for Cooling and a setpoint for Heating are required).

It is possible to configure an initial setpoint, which will be set in the thermostat after a programming from ETS).

The setpoint temperatures may be reset to the initial parameterized values, through a specific reset object.

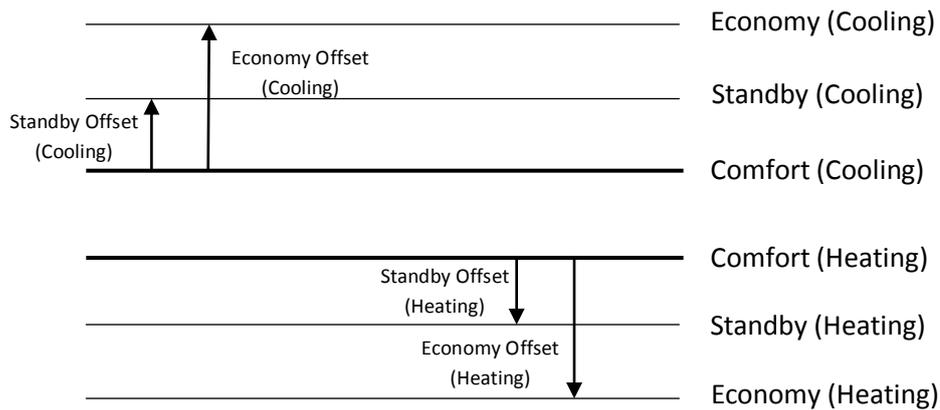Absolute setpoints method is shown in figure 2.9.

Figure 2.9. Absolute setpoints. Cooling and heating mode

When a special mode is activated, the current setpoint temperature will get the configured value for that special mode.

In case the setpoint temperature is modified externally, through the corresponding communication object, it may produce a **change of the current special mode**, if the new setpoint received is higher (or lower) than the setpoint of the next mode. To better understand these concepts, please read the folowing example.

✓ Example:

Suppose the following configuration:

- *Comfort (Cooling) = 23ºC*
- *Standby offset (E) = 3ºC*
- *Economy offset (E) = 5ºC*
- *Comfort (Heating) = 21ºC*
- *Standby offset (C) = -3ºC*
- *Economy offset (C) = -5ºC*

———————————— Economy (E) 28ºC

———————————— Standby (E) 26ºC

———————————— Comfort (Cooling) 23ºC

———————————— Comfort (Heating) 21ºC

———————————— Standby (C) 18ºC

———————————— Economy (C) 16ºC

In Comfort mode (Heating), the setpoint temperature is modified manually, through the communication object, until it reaches 18ºC, when the special mode changes: from Comfort to Standby. If one continues lowering this temperature, until it reaches 16ºC, the mode will switch from Standby to Economy. If an order to change to Comfort arrives, through the corresponding object, the new mode will be Comfort and the setpoint temperature will be now 21ºC.

Although the setpoint is increased, until the functioning mode does not change, from Heating to Cooling, the special mode will be Comfort (Heating).

This working in Heating mode is the same for Cooling mode.

Through the thermostat parameters, it is possible to configure if a change in the special mode or in the functioning mode (Heating/Cooling) sent from any of the associated objects implies a permanent change of the current setpoint or if this change has only effect while the thermostat remains in this concrete mode. If the option **permanently apply change to special mode setpoint** is enabled, the received setpoint will be saved to establish it as setpoint when the mode is activated again.

It is important to know that the new setpoint temperature will **only** be saved when a explicit order of mode change arrives at the thermostat, via an object; the mode changes produced due to new values received in the setpoint object will not save the new setpoint. It is also important to know that setpoint temperatures for Comfort mode lower or higher than the defined ones by parameter for Comfort Cooling and Comfort Heating **will not be saved**. All these points are explained in the following example.

✓ *Example:*

*With the previous example configuration, now some examples of use are shown (the option "permanently apply change to special mode setpoint" is **enabled**):*

- *Case 1: the thermostat is working in special mode Comfort (Cooling) = 23ºC. The setpoint temperature is raised manually to 24ºC and then, it is raised to 27ºC, thus switching to Standby mode and then it is commanded to change to Comfort mode, via the corresponding object. The Comfort (Cooling) setpoint remains 23ºC, since the first special mode change occurred due to a change in the setpoint and not though an explicit change of mode order.*

- *Case 2: the thermostat is working in special mode Standby (Cooling) = 26ºC and it comes an order to change the setpoint to 25ºC and then, an order to activate the Comfort mode. If now the mode is changed again to Standby via communication object, the setpoint of mode now will be 25ºC.*

- *Case 3: the thermostat is working in special mode Comfort (Cooling) = 23ºC and it comes a new setpoint equal to 22ºC, via the corresponding object. The mode is change.d to Economy (Cooling), so the setpoint of this mode is established (28ºC) If now an order to activate the Comfort mode is received, the setpoint that will be established is*

23ºC (the one first parameterized for this mode), because the temperature sent before the change of mode to Economy (22ºC) is lower than the parameterized setpoint for Comfort mode (23ºC).

This permanent saving of the setpoint after a change of mode may be useful when it is desired to modify the setpoint that was set by parameter; for instance, suppose the thermostat in a room is working in Comfort mode (Cooling) at 23ºC, but the user desires a setpoint of 24ºC for this mode. With this option, it will possible to modify the setpoint value (always with a value higher than the parameterized in ETS for Comfort mode (Cooling)) in order to maintain this new value when returning to Comfort after a change of special mode.

2.5.2. RELATIVE SETPOINTS

This method consists of the application of setpoints in a relative way, i.e., a **basic setpoint** is defined by parameter and the setpoints of the special modes will be established via an offset, relative to this basic temperature (mode definition), both for Cooling and for Heating.

Relative setpoints method is shown in figure 2.10.

This method of modes management is ideal for **complex installations**, where a supervisor controls the setpoint temperature of several independent thermostats.
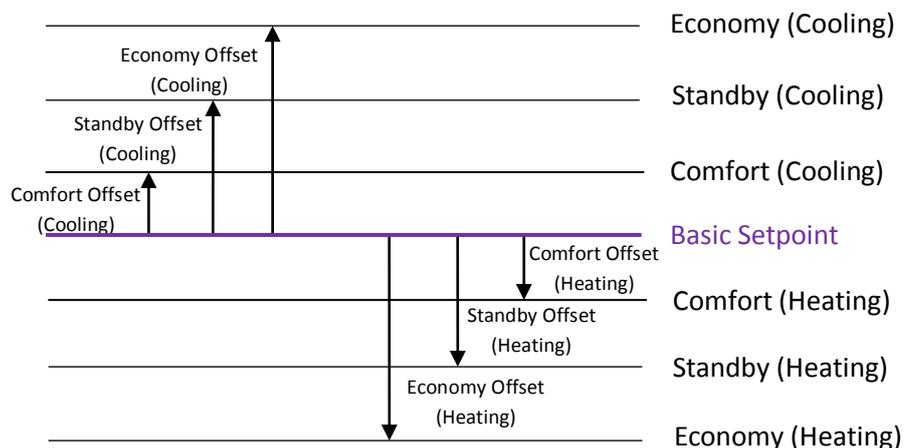
Figure 2.10. Relative setpoints. Cooling and Heating mode

The setpoint temperature of the thermostat can be modified in two different ways: by changing the basic setpoint (through the corresponding communication object) or by adding an offset to the basic temperature (for this aim, there are two specific communication objects).

If the basic setpoint is modified through a communication object, the value of the setpoints of each mode will be updated, adding their parameterized offset to this new basic temperature.

If the basic setpoint is modified by adding an offset, two communication objects are available for this aim: 1-bit object to increase/decrease the global offset value of 0.5ºC in 0.5ºC and a 2-bytes object, where to directly write the **absolute offset** over the current temperature. The value of the offset can be known whenever needed thanks to a status object and this value can be reset (offset = 0) via a reset object.

A change in the offset also modifies the setpoint temperature of the same special mode but of the other functioning mode (Cooling or Heating), in order to carry out the automatic mode switching in a correct way.

The maximum value of the offset to be added or subtracted to the basic setpoint is narrowed by lower and upper limits, defined by parameter.

The special mode definitions cannot be modified by object (only by parameter).

The real working setpoint (Basic setpoint plus the defined special mode shift plus the offset applied to the base, if present) can be known at all times thanks to a status object.

Besides everything above, it is also possible to choose by parameter the **initial mode** (Comfort, Standby or Economy) of the thermostat after a programming, and the parameter **Permanently apply change to basic setpoint shift** can be enabled, which allows saving the current offset value in order to, after a change of mode order (heating to cooling, cooling to heating or special modes switching, the setpoint temperature sets to the basic setpoint defined for the current special mode, plus or minus the established offset (always between the upper and lower limits of the mode). If this parameter is disabled, the value of the offset will reset when an order of change in the special mode comes, but not with an order of change of the functioning mode (Cooling/Heating).

✓ *Example:*

Suppose the following configuration:

- *Basic temperature = 22ºC*

- *Comfort Offset (Cooling) = 1ºC*

- *Standby offset (C) = 3ºC*

- *Economy offset (C) = 5ºC*

- *Comfort (Heating) = -1ºC*

- *Standby offset (H) = -3ºC*

- *Economy offset (H) = -5ºC*

- *Maximum offset = 3ºC*

- *Minimum offset = -2ºC*

————————————————— Economy (C) 27ºC

————————————————— Standby (C) 25ºC

————————————————— Comfort (Cooling) 23ºC

————————————————— **Basic temperature 22ºC**

————————————————— Comfort (Heating) 21ºC

————————————————— Standby (H) 19ºC

————————————————— Economy (H) 17ºC

The option Permanently apply change to basic setpoint shift is enabled.

Suppose the thermostat starts in Standby mode (Cooling). The initial offset is 0. At a given time, an offset increment is sent through the associated 1 bit communication object, so the setpoint of the Standby mode will be 25.5ºC. After, a new offset value is received through the associated 2-bytes object: +4ºC, so the offset is now 4ºC, but the upper limit has been established as 3ºC so the setpoint of the Standby mode will be now 28ºC (25ºC + 3º offset).

Suppose an incoming order to activate the Comfort mode. As the option Permanently apply change to basic setpoint shift is enabled, the accumulated offset (3ºC) is kept, so the new setpoint of the Comfort mode (Cooling) will be 26ºC (if this option is disabled, the offset will be reset when changing the mode and the setpoint temperature will be 23ºC).

If the change of setpoint is received through object (for example, 25ºC), the accumulated offset will not be reset in any case. The values of the modes will be updated, so the new setpoint for the current mode will be 29ºC = new basic setpoint + Comfort offset Cooling + Accumulated offset.

2.5.3. CHANGE OF SPECIAL MODE

As seen before, Zeenio thermostat is always working in one special mode (Protection, Economy, Standby or Comfort). The thermostat will work in one mode or another in function of the required acclimatization conditions.

The current working mode can be knows at all times, via an associated status object.

Manual changes of mode can be carried out by writing the value associated to the mode to be activated in the corresponding object.

It is also possible to carry out this change of mode through 4 individual mode objects, whose working can be set by parameter, selecting the way the switch between modes will be carried out:

🔵 **Trigger:** 4 communication objects are enabled, one per mode, to activate the desired special mode by sending the value "1" through the corresponding object. The sending of the value "0" does not imply any action. Whatever the value of the objects, the thermostat will activate the mode associated to the object where the last "1" was received.

🔵 **Switch:** 4 communication objects are enabled, one per mode, to activate the desired special mode, only if it has **priority** over the previous one. The value "1" in the object indicates activation of the desired mode, taking into account the flowing activation priority, highest to lowest: 1.- Protection / 2.- Comfort / 3.- Standby / 4.- Economy. The value "0" deactivates the corresponding mode.

For the case all the objects have the value "0" at the same time, it is possible to define by parameter the default mode to apply in this situation (Comfort, Stand.by or Economy).

There are two more parameters related to the change of special mode:

🔵 **Comfort prolongation:** it allows activating the Comfort mode during a parameterized time, thus adjusting the room temperature to a comfort value for a longer time.

This option becomes very useful when working together with a movement detector (like the Zennio model **ZN1IO-DETEC**), since the thermostat can be configured to activate the Comfort mode when the sensor detects presence in the room, thus obtaining an optimal ambient and energy saving (because the thermostat may have been acclimatizing the room in Standby or Economy mode while no one was in there).

Window Status: it allows activating the Protection mode preferentially than the rest of modes, since if the window status has been activated is because an "extraordinary" event related to the acclimatization has occurred in the room; for example, a broken window in winter has provoked the room temperature to be too low.

3. ETS PARAMETERIZATION

Next the Zennio thermostat configuration in ETS is shown:

All the options, parameters and aspect of the thermostat configuration window in ETS are the same for all the Zennio devices with thermostat function explained here.

3.1. DEFAULT CONFIGURATION

In the application program there is an exclusive window to configure the **thermostat**, disabled by default. The number of thermostat to configure will vary, depending on the device in use.

Figure 3.1. Thermostat window

When enabling each thermostat, a serial of windows will appear to configure several functionality aspects (see next).
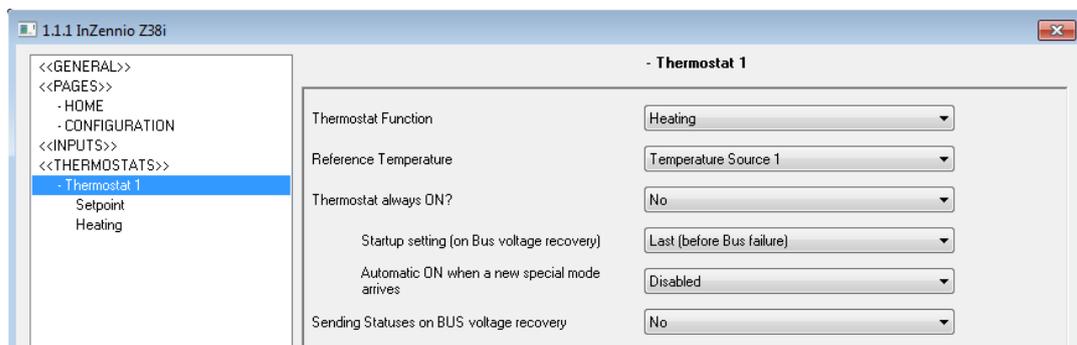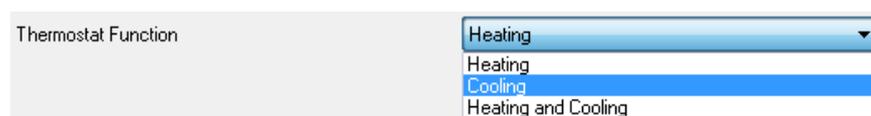
Figure 3.2. General configuration window of the thermostat, by default

3.2. GENERAL CONFIGURATION WINDOW

In the general configuration window of the thermostat (figure 3.2) the following parameters can be customized:

🔵 **Thermostat function:** selection of the functioning mode of the thermostat, to choose among: **Heating, Cooling or Heating and Cooling**.

Depending on the selected option, in the left menu will appear one or two tabs to configure the selected mode or modes (see <u>section 3.4</u> for Heating mode and <u>3.5</u> for Cooling mode).

If the two modes are selected, the following options will appear:

➢ **H/C Automatic switching:** enables the automatic mode switching (Cooling to Heating and Heating to Cooling). If this parameter is disabled, the mode switching will be carried out manually, through the 1 bit communication object "[Tx] Mode", which will set the Cooling mode in the thermostat when receiving the value "0" and in Heating mode with the value "1".

If the automatic switching in enabled, the object "[Tx] Mode" does not appear, because the mode switching is carried put by the thermostat automatically, in function of the reference temperature and the setpoint of the actual mode.

In both cases, the 1 bit object "[Tx] Mode (Status)" is present, to know at all times the current functioning mode of the thermostat ("0" for Cooling and "1" for Heating).

➢ **H/C Mode after programming:** it allows selecting the mode on which the thermostat will start working: Heating or Cooling.

🔵 **Reference temperature:** selection of the source that will provide the real temperature of the room to acclimatize. One or two measure sources can be selected. In case of two, the final reference is a proportion of the measure of both. For this aim two independent sources can be

used, or an external source and the temperature probe that some Zennio product incorporate (like the panel InZennio Z38i).
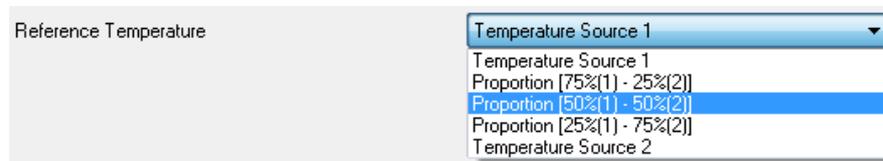
🔵 **Thermostat always ON?:** it allows selecting if the thermostat will be always ON ("Yes") or if it will switch on in certain occasions ("No"), in which case two new communication objects will be enabled: "[Tx] On/Off" and "[Tx] On/Off (Status)", to control the switching on/off of the thermostat and to know its status at all times. Moreover, two new configuration windows will appear:

➢ **Startup setting:** selection of the thermostat status after recovering of a bus power failure, to chose among: off, on or last (last status before bus power failure). If the option "last" is chosen, the status of the thermostat after programming will be OFF.

➢ **Automatic ON when a new special mode arrives:** if this option is enabled, the thermostat will switch on automatically when a new special mode arrives (order received through any of the associated communication objects: the 1-byte object "[Tx] Special Mode" or the 1-bit object "[Tx] Special Mode: name of mode" or if the object "[Tx] Window Status (input)" has the value "1". The thermostat will be also automatically switched on if the Comfort prolongation is activated ("[Tx] Comfort Prolongation" = 1), only if the window status object is deactivated ("0"), since this object disables the Comfort prolongation while activated.

🔵 **Sending statuses on bus voltage recovery:** if this option is enabled, all the communication objects related to the status of the different thermostat options will be sent to the bus, with a delay, in seconds. If a delay equal to 0 is parameterized in this field, the statuses sending is immediate.

3.3. SETPOINT WINDOW

In this ETS window appears a set of specific parameters, depending on the setpoints method to be used in the thermostatic control: **absolute setpoints** or **relative setpoints** method.

To obtain a more detailed explanation about the functioning of both methods, please read the sections 2.5.1 and 2.5.2 of this document, where there are information and use examples of the absolute setpoints and relative setpoints methods, respectively.

Whatever the chosen method, the 1 byte object "[Tx] Special Mode" wwill be enabled, to switch manually between the special modes, by witing one of the following values for each mode:

- "[Tx] Special Mode= '1' → Comfort Mode

- "[Tx] Special Mode= '2' → Standby Mode

- "[Tx] Special Mode= '3' → Economy Mode

- "[Tx] Special Mode= '4' → Protection Mode

The 1 byte object "[Tx] Special Mode (Status)" is shown. It allows knowing the special mode the thermostat is working at a given time.

Next, the configuration parameters associated to each method are explained:

Note: *In all the following figures, it is shown the options for the two setpoints methods, which have been previously configured (in General window: Thermostat function) for a "Cooling and Heating" mode functioning, in order to show and explain all the customizable parameters. If only one functioning mode is selected (Heating or Cooling), it will just appear the options for that mode.*
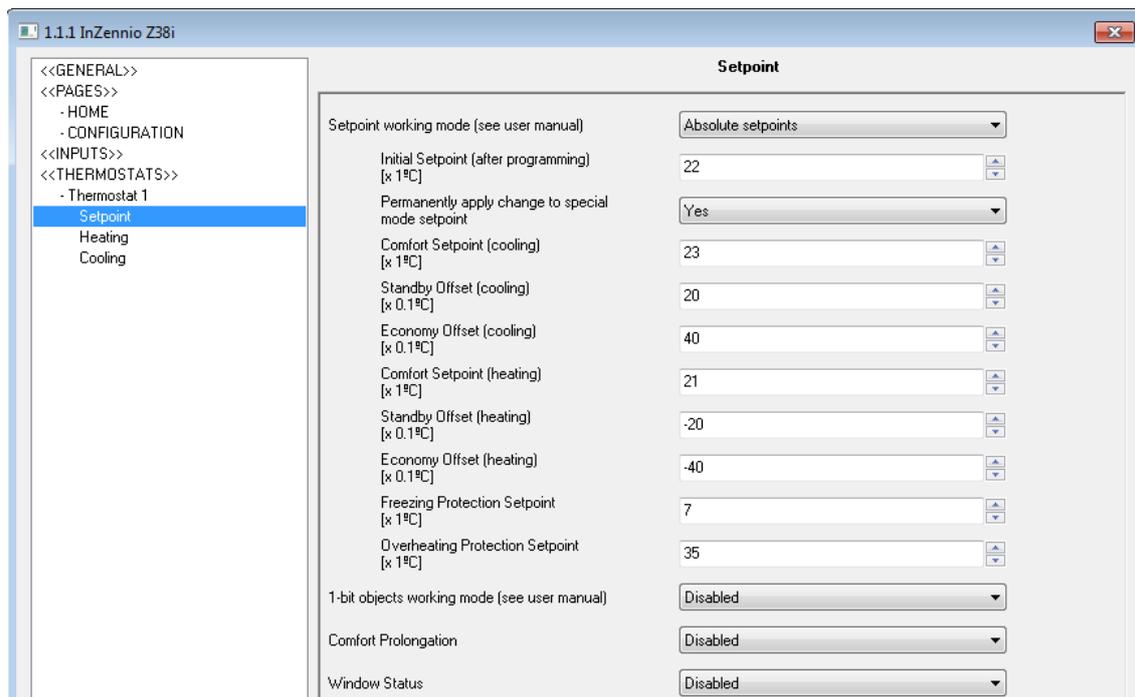
3.3.1. ABSOLUTE SETPOINTS

Figure 3.3. Parameters of the Absolute setpoints method

⚙ **Initial setpoint:** to set an initial setpoint temperature, which will be established by default after programming from ETS, and that will determine the initial special mode. This value can be modified through the 2 bytes communication object "[Tx] Setpoint", depending on the acclimatization needs at a given moment. The thermostat will control then the temperature of the room with this new setpoint value. The value of the current setpoint can be read at all times via the object "[Tx] Setpoint Status". And thanks to the 1 bit object "[Tx] Setpoint Reset", the current setpoint value can be reset to its initial value (parameterized setpoint value for the current special mode of the thermostat), by writing the value "1" in the object,.

⚙ **Permanently apply change to special mode setpoint:** when enabling ("Yes") this option it will be possible to save, after a change of mode (special or Cooling/Heating) through any of the associated communication objects, the new setpoint established for the last mode when it is activated again. If the option is disabled, the new setpoint will not be saved after the change of mode.

⚙ **Comfort setpoint (Cooling):** parameter to define the setpoint temperature, in ºC, for the special mode Comfort (Cooling). This value will be used to define the setpoints of the special modes Standby and Economy in Cooling mode.

🔹 **Standby Offset (Cooling):** to define the temperature value, in tenths of degree, to add to the Comfort setpoint (Cooling) to get the setpoint of the Standby mode (Cooling).

🔹 **Economy Offset (Cooling):** to define the temperature value, in tenths of degree, to add to the Comfort setpoint (Cooling) to get the setpoint of the Economy mode (Cooling).

🔹 **Comfort setpoint (Heating):** parameter to define the setpoint temperature, in ºC, for the special mode Comfort (Heating). This value will be used to define the setpoints of the special modes Standby and Economy in Heating mode.

🔹 **Standby Offset (Heating):** to define the temperature value, in tenths of degree, to subtract to the Comfort setpoint (Heating) to get the setpoint of the Standby mode (Heating).

🔹 **Economy Offset (Heating):** to define the temperature value, in tenths of degree, to subtract to the Comfort setpoint (Heating) to get the setpoint of the Economy mode (Heating).

Note: *For a correct implementation of the H/C Automatic Switching (If enabled), it is **very important** to define a Comfort Setpoint (Cooling) **higher than** the Comfort Setpoint (Heating), at least a **minimum separation of 2ºC** between these two values.*

🔹 **Freezing Protection setpoint:** to set the value of the setpoint temperature of the Freezing protection mode (value between 0 and 15ºC).

🔹 **Overheating Protection setpoint:** to set the value of the setpoint temperature of the Overheating protection mode (value between 30 and 45ºC).

🔹 **1-bit objects working mode:** if any of the two options available (**Trigger** or **Switch**) is enabled, the following 1-bit communication objects will be activated, in order to mode switching in a direct way or applying priorities (please consult section 2.5.3 for further information):

- "[Tx] Special Mode: Comfort"

- "[Tx] Special Mode: Standby"

- "[Tx] Special Mode: Economy"

- "[Tx] Special Mode: Protection"

If this option is disabled, the only way to manually change the special mode is via the 1 byte communication object "[Tx] Special Mode".

🔵 **Comfort Prolongation:** when enabling this parameter, the 1-bit communication object "[Tx] Comfort Prolongation" is shown. When it receives the value "1", the special mode Comfort will be activated,. during the parameterized time, in minutes. If during this time, the object receives the value "1" again, the Comfort prolongation time starts counting again. Once elapsed the time, the Comfort prolongation ends and the thermostat continues working in the previous mode it was before the Comfort prolongation activation. If a new special mode is activated manually or the object "[Tx] Window Status" is enabled ("1"), the Comfort prolongation will be deactivated.

🔵 **Window Status:** when enabling this parameter, a new 1-bit object appears ("[Tx] Window Status (input)"). When it gets the value "1", the Protection mode will be activated with preference to the rest of modes, so any of them can be activated until the window status object is "0". If during the time the window status is active, an order to activate a special mode incomes, this will be taken into account when the window status is deactivated, placing the thermostat into the received special mode.

Note: *If during the time the Comfort prolongation is active, a new order to activate the window is received ("[Tx] Window Status"=1), the special mode switches from Comfort to Protection. When the window status is disabled ("[Tx] Window status" = 0), the special mode of the thermostat will be **the last one it had before the activation of the Comfort prolongation.***
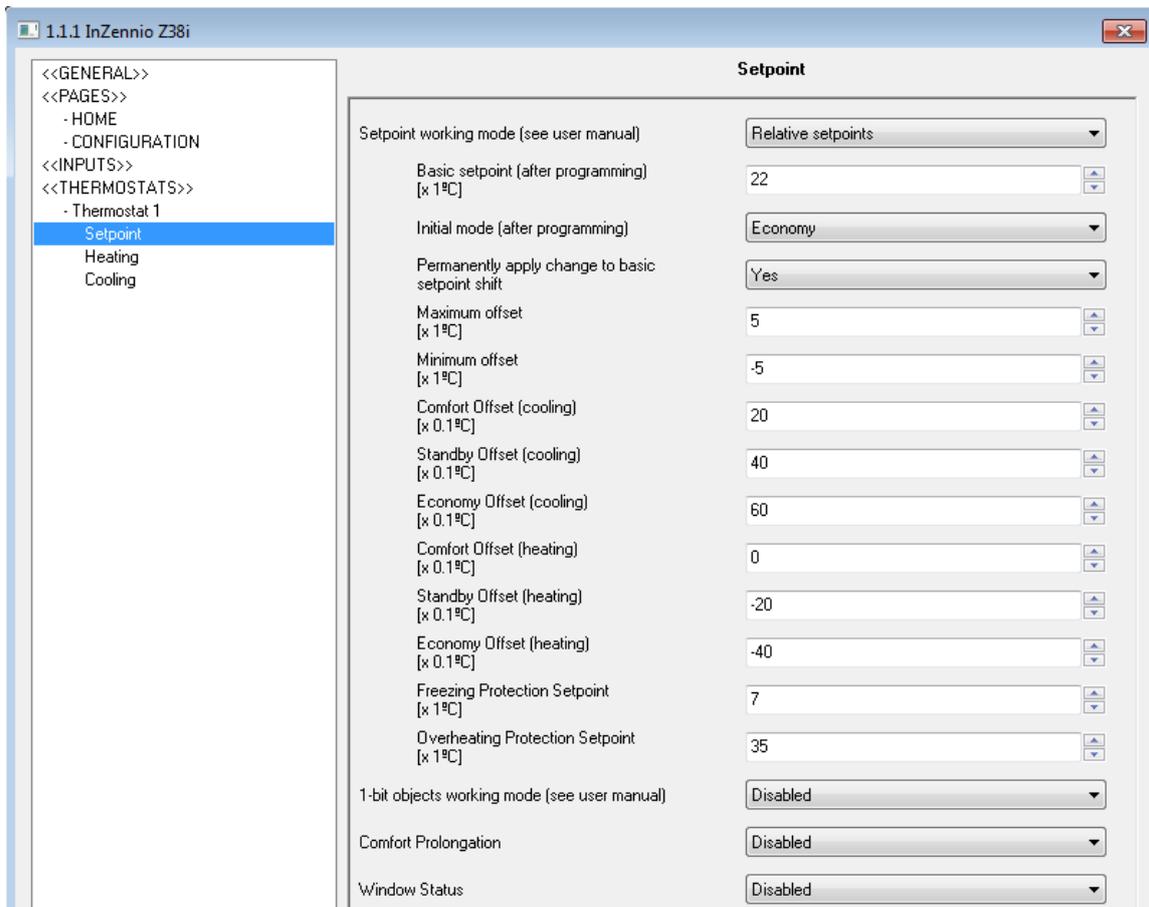
3.3.2. RELATIVE SETPOINTS

Figure 3.4. Parameters of the Relative setpoints method

🔵 **Basic setpoint:** to set the initial value of the setpoint temperature that will be taken as reference to calculate the setpoint of the special modes (for Cooling and Heating), by adding or subtracting the parameterized offset values for each mode. Via the object "[Tx] Basic Setpoint" this temperature can be modified, depending on the acclimatization need of every moment and with the object "[Tx] Basic Setpoint Status" it is possible to know the current value of the basic setpoint.

As mentioned in section 2.5.2, an offset can be applied to this basic setpoint, via two communication objects: "[Tx] Setpoint Step", 1-bit object to increase the offset in 0.5ºC when writing the value "1" on it and to decrease the offset in 0.5ºC when writing the value "0"; and the 2-bytes object "[Tx] Setpoint Offset", to directly send the offset value (float value). The current offset status can be read at any moment through the object "[Tx] Setpoint Offset

Status" and the current offset may be reset to 0 by writing the value "1" in the object "[Tx] Offset Reset".

The 2 bytes object "[Tx] Setpoint Status" allows reading the current setpoint temperature value, i. e., the setpoint value of the mode the thermostat in working at plus (or minus) the accumulated offset, if any.

🔹 **Initial mode:** to set the special mode the thermostat will have after an ETS programming: Comfort, Standby or Economy.

🔹 **Permanently apply change to basic setpoint shift:** if this option is enabled ("Yes"), after a change of mode (special or Cooling/Heating) it will be possible to save the current offset value to apply to the basic setpoint. If it is disabled, the value of the offset will reset (0) when an order of change in the special mode comes, but not with an order of change of the functioning mode (Cooling/Heating).

🔹 **Maximum offset:** maximum value, in ºC, of the offset to add to the basic setpoint.

🔹 **Minimum offset:** maximum value, in ºC, of the offset to subtract to the basic setpoint.

🔹 **Comfort Offset (Cooling):** to define the temperature value, in tenths of degree, to add to the Basic setpoint to get the setpoint of the Comfort mode (Cooling).

🔹 **Standby Offset (Cooling):** to define the temperature value, in tenths of degree, to add to the Basic setpoint to get the setpoint of the Standby mode (Cooling).

🔹 **Economy Offset (Cooling):** to define the temperature value, in tenths of degree, to add to the Basic setpoint to get the setpoint of the Economy mode (Cooling).

🔹 **Comfort Offset (Heating):** to define the temperature value, in tenths of degree, to subtract to the Basic setpoint to get the setpoint of the Comfort mode (Heating).

🔹 **Standby Offset (Heating):** to define the temperature value, in tenths of degree, to subtract to the Basic setpoint to get the setpoint of the Standby mode (Heating).

🔹 **Economy Offset (Heating):** to define the temperature value, in tenths of degree, to subtract to the Basic setpoint to get the setpoint of the Economy mode (Heating).

🔹 **Freezing Protection setpoint:** to set the value of the setpoint temperature of the Freezing protection mode (value between 0 and 15ºC).

Overheating Protection setpoint: to set the value of the setpoint temperature of the Overheating protection mode (value between 30 and 45ºC).

1-bit objects working mode: if any of the two options available (**Trigger** or **Switch**) is enabled, the following 1-bit communication objects will be activated, in order to mode switching in a direct way or applying priorities (please consult section 2.5.3 for further information):

- "[Tx] Special Mode: Comfort"

- "[Tx] Special Mode: Standby"

- "[Tx] Special Mode: Economy"

- "[Tx] Special Mode: Protection"

If this option is disabled, the only way to manually change the special mode is via the 1 byte communication object "[Tx] Special Mode".

Comfort Prolongation: when enabling this parameter, the 1-bit communication object "[Tx] Comfort Prolongation" is shown. When it receives the value "1", the special mode Comfort will be activated,. during the parameterized time, in minutes. If during this time, the object receives the value "1" again, the Comfort prolongation time starts counting again. Once elapsed the time, the Comfort prolongation ends and the thermostat continues working in the previous mode it was before the Comfort prolongation activation. If a new special mode is activated manually or the object "[Tx] Window Status" is enabled ("1"), the Comfort prolongation will be deactivated.

Window Status: when enabling this parameter, a new 1-bit object appears ("[Tx] Window Status (input)"). When it gets the value "1", the Protection mode will be activated with preference to the rest of modes, so any of them can be activated until the window status object is "0". If during the time the window status is active, an order to activate a special mode incomes, this will be taken into account when the window status is deactivated, placing the thermostat into the received special mode.

Note: *If during the time the Comfort prolongation is active, a new order to activate the window is received ("[Tx] Window Status"=1), the special mode switches from Comfort to Protection. When the window status is disabled ("[Tx] Window status" = 0), the special mode of the thermostat will be **the last one it had before the activation of the Comfort prolongation.***

3.4. HEATING MODE WINDOW

This configuration window appears when the options "Heating" or "Heating and Cooling" are selected in the parameter Thermostat Function. Where to configure the following features:

🔵 **Control method:** to select the way the thermostatic control will be carried out, choosing between these options: 2-point control and PI control. For both of them, it can be established a periodical resending, in minutes, of the associated control variable (by writing a value different from 0 in the field "**Resending period**"). This periodical resending will only take place when the thermostat is ON.

➢ **2-point Control**

➢ **PI Control**

To obtain more detailed information about these two control methods, please read the section 2.3 of this document.

🔵 **Additional Heating:** if this parameter is enabled, the 1-bit communication object "[Tx] Additional Heat" will appear. When this object takes the value "1", the order to switch on an additional air-conditioning system will be sent, thus helping reaching the required setpoint temperature as soon as possible. When this object takes the value "0", the order to switch off the additional system will be sent. It is also necessary to define an Additional Heating band, in tenths of degree. It is possible to carry out a **periodical resending**, in minutes, of the object "[Tx] Additional Heat" (only if the thermostat is ON).

To obtain theoretical and practical information about the additional heating working, please read the section 2.4 of this document.

3.5. COOLING MODE WINDOW

This configuration window appears when the options "Cooling" or "Heating and Cooling" are selected in the parameter Thermostat Function. Where to configure the following features:

🔵 **Control method:** to select the way the thermostatic control will be carried out, choosing between these options: 2-point control and PI control. For both of them, it can be established a periodical resending, in minutes, of the associated control variable (by writing a value different from 0 in the field "**Resending period**"). This periodical resending will only take place when the thermostat is ON.

➢ **2-point Control**

➢ **PI Control**

To obtain more detailed information about these two control methods, please read the section 2.3 of this document.

🔵 **Additional Cooling:** if this parameter is enabled, the 1-bit communication object "[Tx] Additional Cool" will appear. When this object takes the value "1", the order to switch on an additional air-conditioning system will be sent, thus helping reaching the required setpoint

temperature as soon as possible. When this object takes the value "0", the order to switch off the additional system will be sent. It is also necessary to define an Additional Cooling band, in tenths of degree. It is possible to carry out a **periodical resending**, in minutes, of the object "[Tx] Additional Cool" (only if the thermostat is ON).

To obtain theoretical and practical information about the additional cooling working, please read the section 2.4 of this document.

In case of having selected as thermostat function the option **Heating and Cooling**, in the cooling mode window will appear the field **Control variables.**
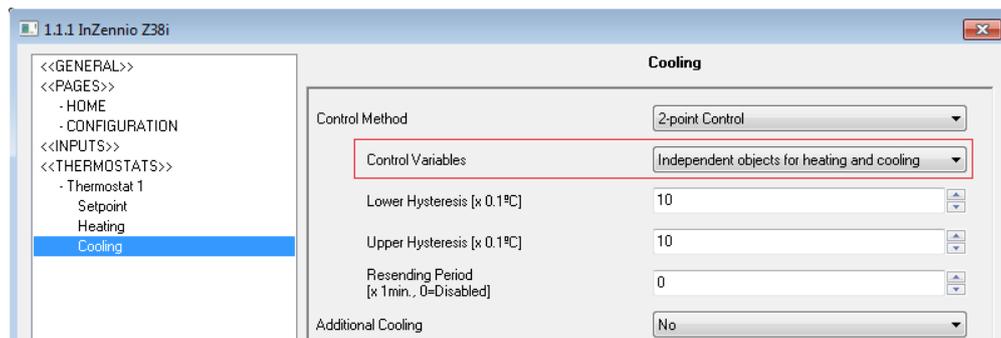
Where to choose one of the following options:

> **Independent objects for heating and cooling:** if this option is chosen, two new communication objects will be enabled, associated to the control variables of every functioning mode: "[Tx] Control Variable (Cool)" and "[Tx] Control Variable (Heat)".

> **One object for both heating and cooling:** just the object "[Tx] Control Variable (Heat)" will be enabled. Through it, the thermostatic control for both cooling and heating modes will be carried out. This option is useful, for instance, in installations with an only climate source.

4. PRACTICAL QUESTIONS

In this section it can be found a series of notes to take into account for configuring and understanding the thermostat performance in Zennio´s devices.

4.1. AUTOMATIC MODE SWITCHING

When a setpoint temperature is established, the thermostat sends the control value so that the real temperature reaches the setpoint, whatever the current functioning mode (Cooling or Heating).

The automatic mode switching is based on the difference between the real temperature and the setpoint temperature for heating and cooling for the current special mode.

The **automatic switching from heating to cooling** will take place when the reference (real) temperature is higher than the setpoint of the current special mode, for the Cooling mode.

The **automatic switching from cooling to heating** will take place when the reference (real) temperature is lower than the setpoint of the current special mode, for Heating mode.

Note: *It is important to carry out a correct configuration of the setpoints for Cooling and Heating modes. It must be taken into account that **the cooling setpoints must be always higher than the heating setpoints** so that the automatic mode switching is carried out correctly.*

✓ Example:

Suppose the setpoint temperature for Standby mode (Cooling) is 27ºC and for Standby (Heating), 16ºC. The thermostat is working in heating mode, with the H/C Automatic switching enabled. At a given moment, the reference temperature starts raising. The automatic switching from Heating to Cooling will take place when this temperature is higher than 27ºC. If, later, the reference temperature starts lowering, a new automatic mode switching can take place, from Heating to Cooling, if the reference is lower than 16ºC. See this behaviour in the figure 4.1.
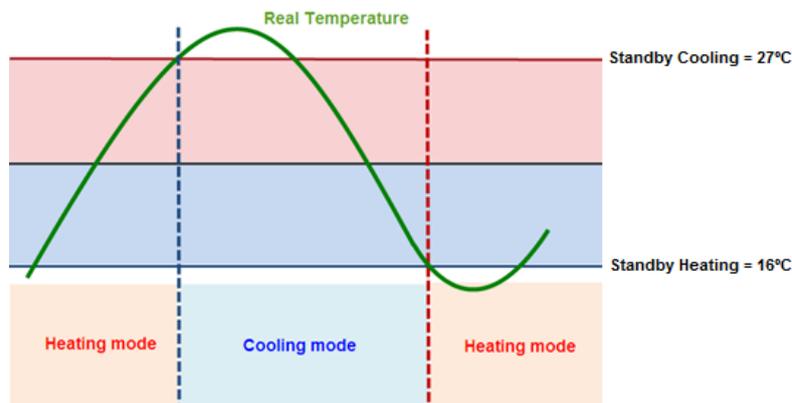
Figure 4.1. H/C Automatic Switching example

4.2. PARAMETERIZING THE PI CONTROL

When configuring a **Proportional Integral (PI)** Thermostatic Control, one can customize a series of options, as seen in figure 4.2: **Control type**, **PI cycle**, **Control Parameters** and **Resending period**.

Figure 4.2. PI-Continuous in Heating mode

In **Control type** it is possible to select **Continuous (1 byte)** or **PWM (1 bit)** control. In section 2.3.2 of this document there is complete information and application examples of both control types.

The **PI cycle** establishes the sending period of the thermostat control signal, in minutes. This value depends a lot on the thermal lag of the air-conditioning system that is being installed. For systems with low thermal lag, the cycle time has to be higher, for instance, a radiant floor will need a cycle time of 30 to 50 minutes, since its thermal lag is slower, whereas an air system just needs 8 to 12 minutes, since its thermal lag is faster.

The **Control Parameters** allow selecting the type of air-conditioning system used for the integral calculation of the control variable. It is possible to choose among a list of predefined values, for typical systems, depending on the functioning mode, or to do an advanced parameterization.

System	K	T (min)
Warm Water	5	150
Floor Heating	5	240
Electric Heating	4	100
Blow Convector	4	90
A/C Split	4	90
Advanced	Param.	Param.

Figure 4.3. Control parameters for Heating mode

System	K	T (min)
Cooling Ceiling	5	240
Blow Convector	4	90
A/C Split	4	90
Advanced	Param.	Param.

Figure 4.4. Control parameters for Cooling mode

Each of the systems presented has been internally parameterized to obtain the **best performance**. The prefixed parameters K and T correspond to trials, thus ensuring an ideal behaviour when controlling the room temperature, depending on the selected mode.

If the option Advanced is chosen, it will be necessary to introduce values for the proportional ban (parameter K, in kelvin) and for the integral time (T, in minutes), besides selecting if the accumulated error on saturaion is reset or not.

Figure 4.5. Control Parameters: Advanced

If the option "Reset accumulated error on saturation" is enabled, the following behaviour for PI control is noticed:

When the reference and the setpoint temperature are really far away from each other, the corresponding control variable will take the value 100% (PI Continuous) or "1" (PI PWM), being this value the saturation status of the signal, and the control variable will not change its value until the reference is equal to the parameterized setpoint, when the control variable will take the value 0% (or "0") all the cycle time After this reset, the PI control system will start working as usual.

The predefined control parameters always work with this option (reset accumulated error on saturation) enabled.

Note: *To ensure a correct performance of the system it is hardly recommended to choose between the* **defined options** *according to the air-conditioning system, since only air conditioning experts will be able to select the suitable configuration in every case.*

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